Postgraduate Certificate
Quantum Physics

tech technological university

tech technological university

Postgraduate Certificate
Quantum Physics

- Modality: **online**
- Duration: **12 weeks**
- Certificate: **TECH Technological University**
- Dedication: **16h/week**
- Schedule: **at your own pace**
- Exams: **online**

Website: **www.techtitute.com/us/engineering/postgraduate-certificate/quantum-physics**

Index

01

Introduction

Behind many of today's technological advances such as fiber optics, wireless communications, lasers or nuclear magnetic resonance, quantum physics plays a leading role. In recent years, studies and work focused on the creation of quantum computers have also intensified, generating an important fascination in the society. Therefore, it is essential to know this branch of physics, for the development of projects in the field of engineering. For this reason, this educational institution has created this 100% online program, which provides essential knowledge about the most common physical processes and the main postulates. Also, with an innovative multimedia content that can be accessed 24 hours a day from a computer with Internet connection.

With this Postgraduate Certificate in Quantum Physics, you will gain the necessary knowledge to develop projects in the field of communication or computing"

Energy production, ultracold atoms, trapped ions or photonics are currently a field of development for engineering professionals who wish to immerse themselves in the field of quantum physics. The essential knowledge on this branch of science has undoubtedly contributed to current communications, to the promotion of new technologies and to the progress of other disciplines.

Understanding matter at very small scales: at molecular, atomic and even smaller levels is key for the engineers who wish to advance in their career, either by implementing their own ideas or by participating in projects in renowned companies. For this reason, TECH has created this Postgraduate Certificate in Quantum Physics, in which, in just 12 weeks, the professional will gain the knowledge required to thrive in their field.

A program where students, from the beginning, will learn the main concepts of this specialty, the main laws that govern it, its postulates and the problems that can be solved by applying quantum mechanics. For this purpose, it has multimedia teaching resources that can be easily accessed 24 hours a day, from any computer, tablet or cell phone with Internet connection.

The professionals are thus facing an excellent opportunity to study a 100% online and flexible program, that allows them to combine their work and/or personal responsibilities with quality education. In addition, the Relearning method, used by TECH in all its programs, will help reduce the long hours of study, which are more common in other teaching systems.

This **Postgraduate Certificate in Quantum Physics** contains the most complete and up-to-date program on the market. The most important features include:

- Practical case studies are presented by experts in Physics
- The graphic, schematic, and practical contents with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- Practical exercises where the self-assessment process can be carried out to improve learning
- Its special emphasis on innovative methodologies
- Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- Content that is accessible from any fixed or portable device with Internet connection

Obtain the fundamentals of Quantum Physics you need to thrive in your engineering career"

In this program, you will be able to learn the Wentzel-Kramers-Brillouin (WKB) method, comfortably from your computer or tablet with Internet connection"

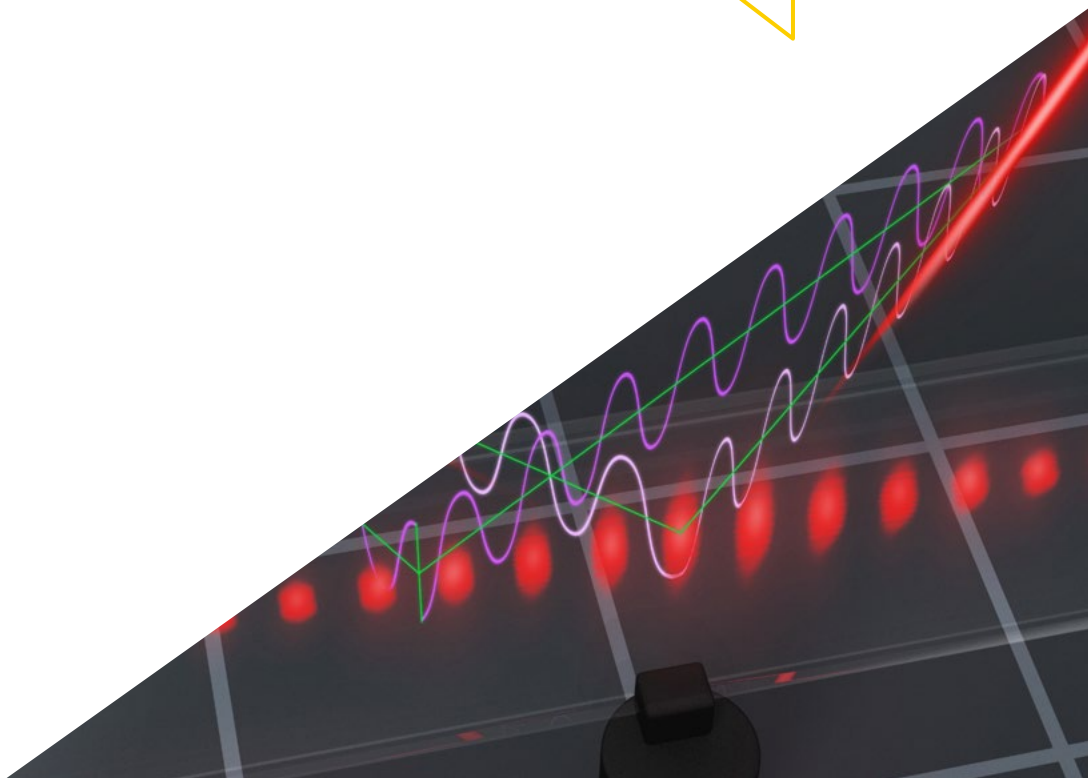
This is a 100% online program that is compatible with the most demanding professional responsibilities.

Click and enroll for a program that will teach you the application of the postulates of quantum mechanics.

The program's teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

The multimedia content, developed with the latest educational technology, will provide the professional with situated and contextual learning, i.e., a simulated environment that will provide immersive education programmed to learn in real situations.

This program is designed around Problem-Based Learning, whereby the professional must try to solve the different professional practice situations that arise throughout the program. For this purpose, the student will be assisted by an innovative interactive video system created by renowned and experienced experts.



02

Objectives

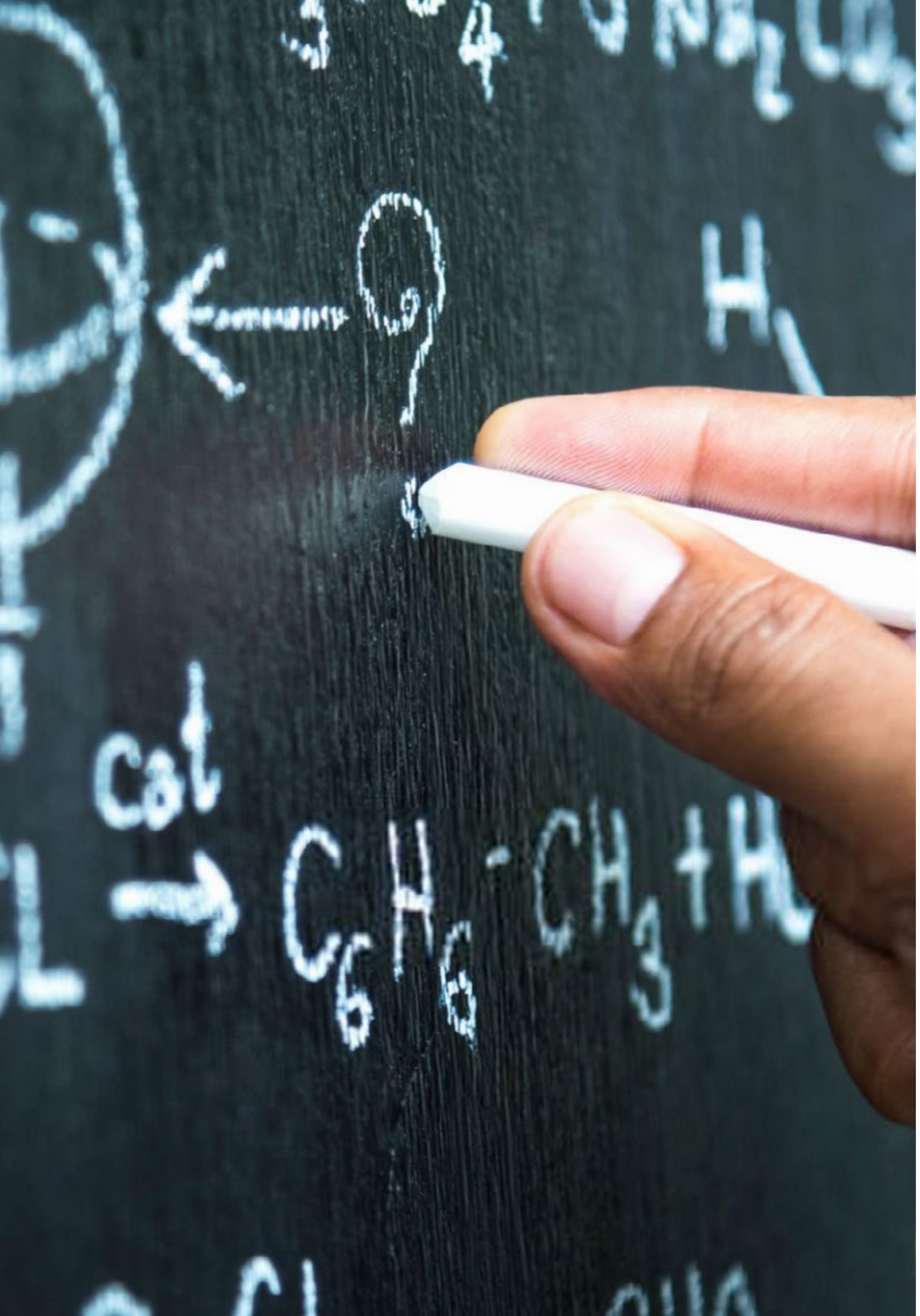
TECH applies the latest technology in the teaching resources provided to the professionals. Thanks to them, the professionals will be able to gain the essential knowledge on Quantum Physics required by all Engineers. Thus, upon completion they will be able to understand the most common physical processes in this field, apply mathematical tools to solve quantum mechanics problems or understand the theory of time-dependent perturbations.

This Program will allow professionals to understand the laws of physics, their articulation and their different existing theories"

General Objectives

- Develop an open and critical mind, the key to understand the physical laws at subatomic level
- Apply the fundamental concepts of Quantum Physics and their articulation in laws and theories
- Know the atomic models with the variational method

You will be able to understand each and every concept of this program thanks to the specialized teaching staff, who will solve any doubts you may have about the syllabus"



Specific Objectives

- Know the most common physical processes in Quantum Physics
- Familiarize with the postulates of Quantum Physics
- Know how to apply the mathematical tools characteristic of Quantum Physics to solve quantum problems in mechanics
- Master the intrinsic angular momentum
- Understand time-dependent perturbation theory
- Understand and know how to apply the WKB method

03

Structure and Content

The syllabus of this program has been designed to obtain the most advanced and relevant information about Quantum Physics in only 12 weeks. Thus, after an introduction to the origins of this branch of science, professionals will learn about the postulates of quantum mechanics, its applications, dynamics, the harmonic oscillator or the method (WKB). For this purpose, they will also have access to a library of resources available 24 hours a day and to which they will have easy access from a computer or tablet with Internet connection.

Thanks to the case studies of this program, you will delve into Spin in a more practical way"

Module 1. Quantum Physics

1.1. Origins of Quantum Physics
- 1.1.1. Blackbody Radiation
- 1.1.2. Photoelectric Effect
- 1.1.3. Compton Effect
- 1.1.4. Atomic Spectra and Models
- 1.1.5. Pauli Exclusion Principle
  - 1.1.5.1. Zeeman Effect
  - 1.1.5.2. Stern-Gerlach Experiment
- 1.1.6. Broglie Wavelength and the Double Slit Experiment

1.2. Mathematical Formulation
- 1.2.1. Hilbert Spaces
- 1.2.2. Dirac Nomenclature Bra - ket
- 1.2.3. Internal and External Product
- 1.2.4. Linear Operators
- 1.2.5. Hermetic Operators and Diagonalization
- 1.2.6. Sum and Tensor Product
- 1.2.7. Density Matrix

1.3. Quantum Mechanics Postulates
- 1.3.1. Postulate 1º: Definition of Status
- 1.3.2. Postulate 2º: Definition of Observables
- 1.3.3. Postulate 3º: Definition of Measurement
- 1.3.4. Postulate 4º: Probability of Measurement
- 1.3.5. Postulate 5º: Dynamics

1.4. Apply the Postulates of Quantum Mechanics
- 1.4.1. Probability of Results: Statistics
- 1.4.2. Indeterminism
- 1.4.3. Temporary Evolution of the Expected Values
- 1.4.4. Compatibility and Commuting of Observables
- 1.4.5. Pauli Matrices

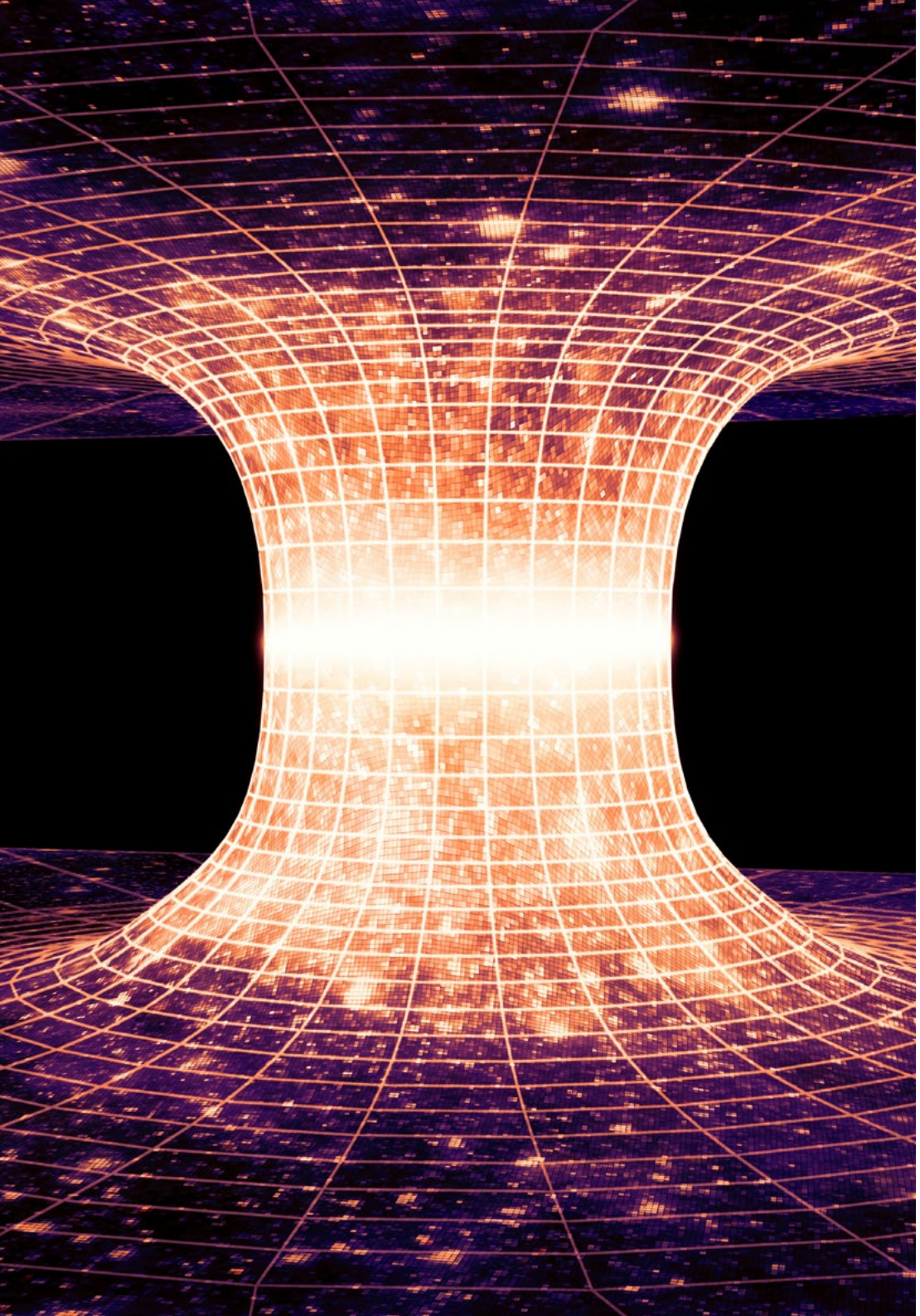
1.5. Quantum Mechanics Dynamics
- 1.5.1. Representation of Positions
- 1.5.2. Momentum Representation
- 1.5.3. Schrödinger Equation
- 1.5.4. Ehrenfest Theorem
- 1.5.5. Virial Theorem

1.6. Potential Barriers
- 1.6.1. Infinite Square Well
- 1.6.2. Finite Square Well
- 1.6.3. Potential Step
- 1.6.4. Delta Potential
- 1.6.5. Tunnel Effect
- 1.6.6. Free Particle

1.7. Simple Harmonic Oscillator
- 1.7.1. Analogy with Classical Mechanics
- 1.7.2. Hamiltonian and eigenvalues of energy
- 1.7.3. Analytical Method
- 1.7.4. Blurred Quantum
- 1.7.5. Coherent States

1.8. 3D Operators and Observables
- 1.8.1. Review of Calculus Notions with Several Values
- 1.8.2. Position Operator
- 1.8.3. Linear Momentum Operator
- 1.8.4. Orbital Angular Momentum
- 1.8.5. Ladder Operators
- 1.8.6. Hamiltonian

1.9. Three-Dimensional Eigenvalues and Eigenfunctions
- 1.9.1. Position Operator
- 1.9.2. Linear Momentum Operator
- 1.9.3. Orbital Angular Momentum and Spherical Harmonics Operator
- 1.9.4. Angular Equation



1.10. Three-Dimensional Potential Barriers
- 1.10.1. Free Particle
- 1.10.2. Particle in a Box
- 1.10.3. Central Potentials and Radial Equations
- 1.10.4. Infinite Spheric Well
- 1.10.5. Hydrogen Atom
- 1.10.6. 3D Harmonic Oscillator

Module 2. Quantum Physics II

2.1. Descriptions of Quantum Mechanics: Images or Representations
- 2.1.1. Schrödinger Picture
- 2.1.2. Heisenberg Picture
- 2.1.3. Dirac Picture or Interaction Picture
- 2.1.4. Change of Pictures

2.2. 3D Harmonic Oscillator
- 2.2.1. Creation and annihilation operators
- 2.2.2. Wave Functions of Fock States
- 2.2.3. Coherent States
- 2.2.4. States of Minimum Indeterminacy
- 2.2.5. Squeezed States

2.3. Angular Momentum
- 2.3.1. Rotations
- 2.3.2. Switches of Angular Momentum
- 2.3.3. Angular Momentum Basis
- 2.3.4. Scale Operators
- 2.3.5. Matrix Representation
- 2.3.6. Intrinsic Angular Momentum: The Spin
- 2.3.7. Spin Cases 1/ 2, 1, 3/ 2

2.4. Multi-Component Wave Functions: Spinorials
- 2.4.1. Single-Component Wave Functions: Spin
- 2.4.2. Two-Component Wave Functions: 1/2 Spin
- 2.4.3. Expected Value of Spin Observable
- 2.4.4. Atomic States
- 2.4.5. Addition of Angular Momentum
- 2.4.6. Clebsch-Gordan Coefficient

2.5. State of the Compound Systems
- 2.5.1. Distinguishable Particles
- 2.5.2. Indistinguishable Particles
- 2.5.3. Photon case: semitransparent mirror experiment
- 2.5.4. Quantum Bonding
- 2.5.5. Bell Inequalities
- 2.5.6. EPR Paradox
- 2.5.7. Bell Theorem

2.6. Introduction to Approximate Methods: Variational Method
- 2.6.1. Introduction to the Variational Method
- 2.6.2. Linear Variations
- 2.6.3. Rayleigh-Ritz Variational Method
- 2.6.4. Harmonic Oscillator: A Study by Variational Methods

2.7. Study of Atomic Models with the Variational Method
- 2.7.1. Hydrogen Atom
- 2.7.2. Helium Atom
- 2.7.3. Ionized Hydrogen Molecule
- 2.7.4. Discrete Symmetries
  - 2.7.4.1. Parity
  - 2.7.4.2. Temporary Inversion

2.8. Introduction to Disturbance Theory
- 2.8.1. Time-Independent Perturbations
- 2.8.2. Non-Degenerate Case
- 2.8.3. Degenerate Case
- 2.8.4. Fine Structure of Hydrogen Atom
- 2.8.5. Zeeman Effect
- 2.8.6. Coupling Constant between Spins. Hyperfine Structure
- 2.8.7. Time-Dependent Perturbation Theory
  - 2.8.7.1. Two-Level Atom
  - 2.8.7.2. Sinusoidal Perturbation

2.9. Adiabatic Approximation
- 2.9.1. Introduction to Adiabatic Approximation
- 2.9.2. The Adiabatic Theorem
- 2.9.3. Berry Phase
- 2.9.4. Aharonov-Bohm Effect

2.10. Wentzel-Kramers-Brillouin (WKB) Approximation
- 2.10.1. Introduction to the WKB Method
- 2.10.2. Classical Region
- 2.10.3. Tunnel Effect
- 2.10.4. Connection Formulas

A 100% online program that will teach you the adiabatic approach and the Aharonov-Bohm effect"

04

Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning.**

This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.

Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"

Case Study to contextualize all content

Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world"

You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.

The student will learn to solve complex situations in real business environments through collaborative activities and real cases.

A learning method that is different and innovative

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

> *Our program prepares you to face new challenges in uncertain environments and achieve success in your career"*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

Relearning Methodology

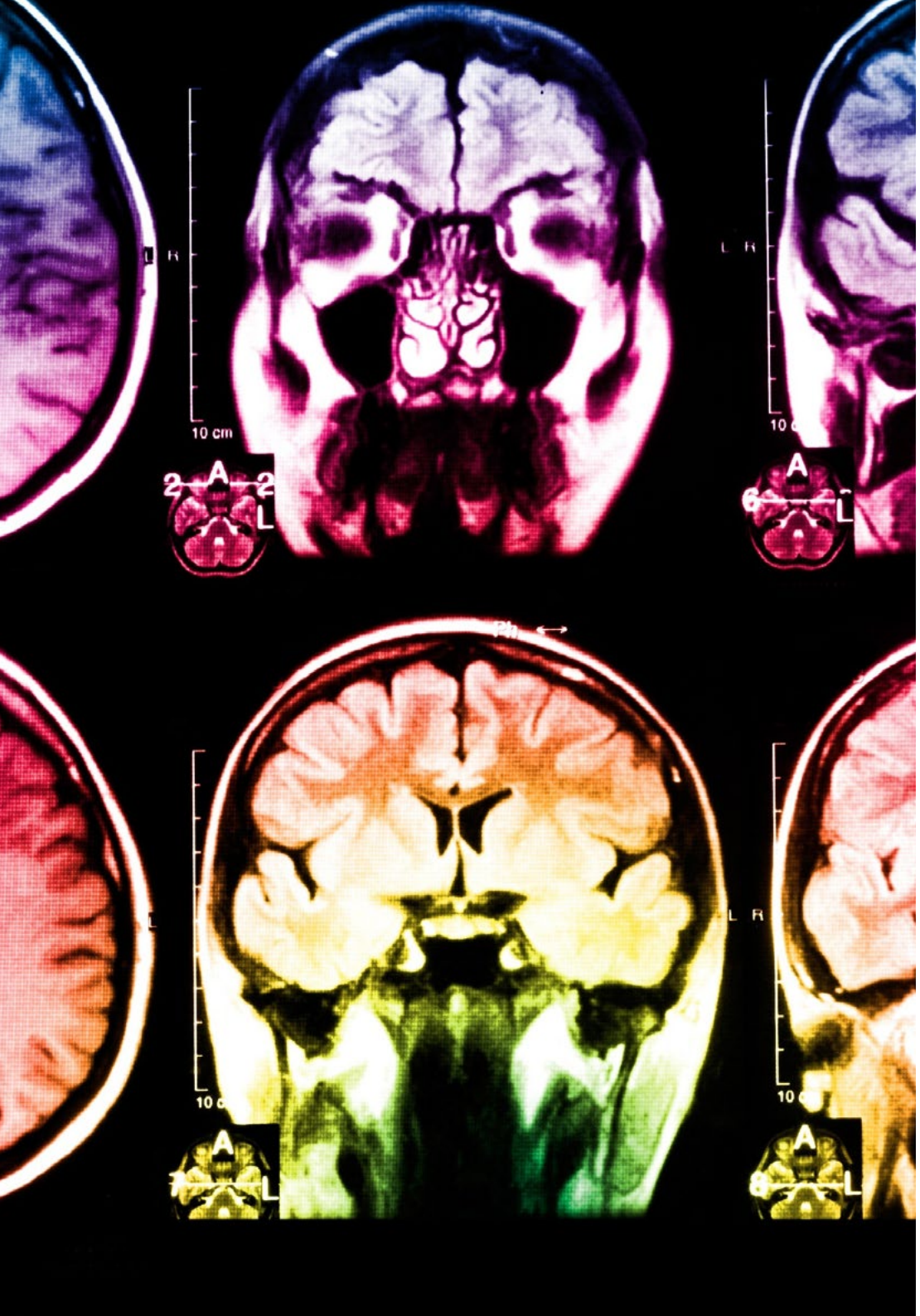
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

In 2019, we obtained the best learning results of all online universities in the world.

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.



In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically. This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

This program offers the best educational material, prepared with professionals in mind:

Study Material

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.

Classes

There is scientific evidence suggesting that observing third-party experts can be useful.

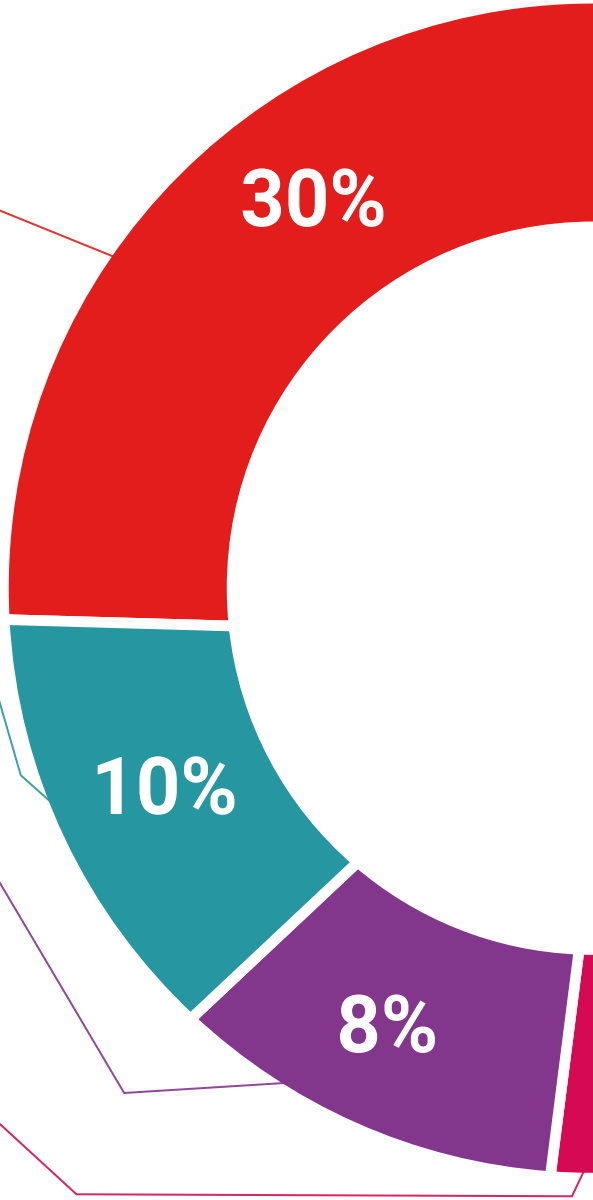
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

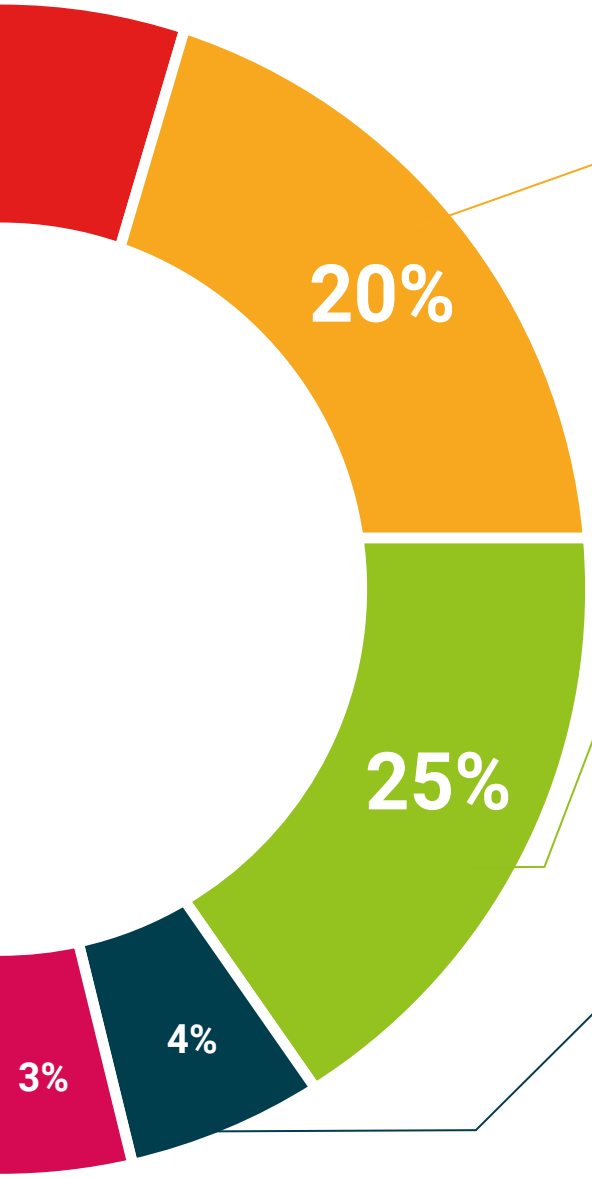
Practising Skills and Abilities

They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.

Additional Reading

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.





Case Studies

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.

Interactive Summaries

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".

Testing & Retesting

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.

05

Certificate

The Postgraduate Certificate in Quantum Physics guarantees professionals, in addition to the most rigorous and up-to-date education, access to a Postgraduate Certificate issued by TECH Technological University.

Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork"

This **Postgraduate Certificate in Quantum Physics** contains the most complete and up-to-date program on the market.

After the student has passed the assessments, they will receive their corresponding **Postgraduate Certificate** issued by **TECH Technological University** via tracked delivery*.

The diploma issued by **TECH Technological University** will reflect the qualification obtained in the Postgraduate Certificate, and meets the requirements commonly demanded by labor exchanges, competitive examinations, and professional career evaluation committees.

Title: **Postgraduate Certificate in Quantum Physics**

Official Nº of hours: **300 h.**


tech technological university

Awards the following

CERTIFICATE

to

Mr./Ms. _____, with identification number _____.

For having passed and accredited the following program

POSTGRADUATE CERTIFICATE

in

Quantum Physics

This is a qualification awarded by this University, equivalent to 300 hours, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH is a Private Institution of Higher Education recognized by the Ministry of Public Education as of June 28, 2018.

June 17, 2020

Tere Guevara Navarro

Dean

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country. Unique TECH Code: AFWORD23S techtitute.com/certificates

*Apostille Convention. In the event that the student wishes to have their paper diploma issued with an apostille, TECH EDUCATION will make the necessary arrangements to obtain it, at an additional cost.

tech technological university

Postgraduate Certificate
Quantum Physics

- Modality: **online**
- Duration: **12 weeks**
- Certificate: **TECH Technological University**
- Dedication: **16h/week**
- Schedule: **at your own pace**
- Exams: **online**

Postgraduate Certificate
Quantum Physics

tech technological university